step 3


1 identify hazards
2 profile hazard events
3 inventory assets
4 estimate losses

3 inventory assets

Overview

The third step in the risk assessment process answers the question: What assets in the community or state will be affected by the hazard event?

Now that you know where natural hazard events can affect your community or state, you will conduct an inventory of the vulnerable assets. The inventory will help you understand what can be affected by the different hazard events.

You will first develop and map a general inventory of assets in your community or state. Then, using the maps developed previously in Step 2, you will identify the assets inside your hazard areas. For example, using your floodplain maps from Step 2, you will identify all of the assets within the 100-year floodplain boundary. However, some hazards can affect the entire community (such as earthquakes or tornadoes) and some will only affect limited areas. Thus, the unique combinations of hazards that can affect you will determine how much inventory collection will be appropriate. An initial inventory can be done very quickly and easily using the baseline data contained in HAZUS.

(continued on page 3-4)

Your community's assets may include hospitals, schools, museums, apartment buildings, and public infrastructure or utilities such as bridges or overhead power lines.

Information regarding the amount of population and building stock located in the hazard areas can provide a powerful initial glimpse into the nature of the community's vulnerability to natural hazards. This can help secure political and community support and funding for mitigation planning and for the projects to be later identified.

HAZUS

HAZUS contains inventory information for every community in the United States. While HAZUS is currently used for generating earthquake loss estimates, it can also be used to inventory elements exposed to other hazards. The package includes GIS maps showing schools, street roadway maps at the county level, SLOSH basin maps outlining areas that can be inundated by hurricane surges, Q3 flood data maps indicating floodplains at the county level, and land use/land cover maps, among others.

HAZUS also allows users to update and add location-specific data. For more information on using HAZUS, see the HAZUS Users Manual or contact your FEMA regional office.

A GIS system will also allow your community to access and use the data available in HAZUS. For example, if you have a GIS flood layer, you may be able to estimate the number of people living in or near flood hazards areas by census tract or compute the current value of property located in the flood hazard area. In either case, two things are important:

Be consistent. In order to perform any comparisons in subsequent steps and phases of the mitigation planning, you should strive to use a consistent method for evaluating and recording information about elements of your community. This is especially important if more than one person will be gathering information. You want to avoid subjective opinions and judgments from the process as much as possible.

Keep good records. The information you collect at this phase will be of value throughout the remainder of the planning process.

Worksheet #3a — Inventory Assets — step 3

Date: July, 2001 *What will be affected by the hazard event?*

Task A. Determine the proportion of buildings, the value of buildings, and the population in your community or state that are located in hazard areas.

Hazard Flood

Type of Structure (Occupancy Class)	Number of Structures			Value of Structures			Number of People		
	# in Community or State	# in Hazard Area	% in Hazard Area	$ in Community or State	$ in Hazard Area	% in Hazard Area	# in Community or State	# in Hazard Area	% in Hazard Area
Residential	61	16	25%	3,927,000	439,000	11%	403	69	7%
Commercial	5	4	80%	6,500,000	4,500,000	69%	570	345	61%
Industrial	0	0	0%	0	0	0	0	0	0
Agricultural	2	1	50%	175,000	90,000	51%	10	5	50%
Religious/ Non-profit	3	1	33%	3,450,000	1,500,000	43%	351	1	0.2%
Government	7	5	71%	7,055,000	2,555,000	36%	570	170	30%
Education	1	1	100%	500,000	500,000	100%	125	125	100%
Utilities	2	2	100%	2,750,000	2,750,000	100%	15	15	100%
Total	81	30	37%	24,351,000	11,884,000	49%	2,044	730	44%

Task B. Determine whether (and where) you want to collect additional inventory data.

	Y	N
1. Do you know where your greatest damages may occur in your hazard areas?	✓	
2. Do you know whether your critical facilities will be operational after a hazard event?		✓
3. Is there enough data to determine which assets are subject to the greatest potential damages?	?	
4. Is there enough data to determine whether significant elements of the community are vulnerable to potential hazards?	✓	
5. Is there enough data to determine whether certain areas of historic, environmental, political, or cultural significance are vulnerable to potential hazards?	✓	
6. Is there concern about a particular hazard because of its severity, repetitiveness, or likelihood of occurrence?	✓	
7. Is additional data needed to justify the expenditure of community or state funds for mitigation initiatives?	✓ Joe, I think we need to do some more research.	

Worksheet #3b Inventory Assets step 3

Date: August, 2001 *What will be affected by the hazard event?*

Task C. Compile a detailed inventory of what can be damaged by a hazard event.

Inventory the assets (critical facilities, businesses, historic, cultural, and natural resource areas, and areas of special consideration), that can be damaged by a hazard event.

Hazard Flood

Name or Description of Asset	Sources of Information	Critical Facility ✓	Vulnerable Populations ✓	Economic Assets ✓	Special Considerations ✓	Historic/Other Considerations ✓	Size of Building (sq ft)	Replacement Value ($)	Contents Value ($)	Function Use or Value ($)	Displacement Cost ($ per day)	Occupancy or Capacity (#)	Other Hazard Specific Information
Historic Lighthouse	Lighthouse Preservation Society					✓	3,000	$150,000	$1.5M	$0.5M	$500	1	
Bridge	Public Works	✓					250 ft long	$750,000	NA	$31,750	$12,000	20	
Sewage Treatment Plant	Public Works	✓					75,000	$2.5M	$2.5M	$30M	$200,000	10	
STP Outbuilding	Public Works	✓					10,000	$1M	$1.5M	$0.25M	$5,000	—	
STP Outbuilding	Public Works	✓					7,500	$75,000	$1.5M	$0.5M	$1,000	—	
Water Treatment Plant	Public Works	✓					3,000	$250,000	$1.25M	$1M	$2,000	5	
Hospital	Hospital	✓					45,000	$2.5M	$3.75M	$0.75M	$2,500	100	
Police/Fire Station	Police Dept.	✓					10,000	$2M	$3M	$0.35M	$2,000	150	

(continued from page 3-1)

HAZUS can summarize the number and value of structures in your jurisdiction by the types of structure or the occupancy class. For example, if you wanted to know how many residential or commercial structures were in your community or state, you would select a summary by the building occupancy class. If you wanted to know how many manufactured homes or wood framed buildings were in your community or state, you would select a summary by the building structure type.

After assessing the number and value of the buildings and the size of the population within the hazard areas, you will decide if you should end your inventory data collection or continue to gather additional information to identify the extent to which the assets would be damaged by the hazard events. If you decide to gather additional information, you will then collect details on specific types of population, building stock, infrastructure, and lifelines in the hazard areas in the order of their importance to the community. This information will be necessary to generate the loss estimations you will make in Step 4.

States can use worksheet #3 to compile the inventory data from each of the local community risk assessments.

You will use **Worksheet #3: Inventory Assets** in Appendix C (see example on pages 3-2 and 3-3) to keep track of the inventory data you will gather. Photocopy the worksheet for each hazard you are assessing. If you have many assets to inventory, you may want to use HAZUS databases or create a computerized spreadsheet to make your data collection efforts more manageable.

Procedures & Techniques

Task A. Determine the proportion of buildings, the value of buildings, and the population in your community or state that are located in hazard areas.

U.S. Census Bureau TIGER files are available from http://www.census.gov/geo/www/tiger.

1. Estimate or count the total number of buildings, value of buildings, and number of people in your community or state.

Using local resources, Census data, HAZUS, or other GIS capabilities, you will determine the total number and value of buildings and the population within your jurisdiction.

To estimate the total replacement value of the buildings in your community or state, multiply the average building replacement value by the number of buildings. HAZUS can help you.

a. **Determine the total number of buildings inside your community or state.** Identify the total number of buildings located within your community or state.

Remember that so far, you have only been considering one hazard event for each hazard type. Later in the process, you may find the need to assess additional or possibly all potential hazard events. This may expand or decrease your planning area.

This information can be grouped by occupancy class, such as residential, commercial, or industrial in HAZUS or can be gathered from a tax assessment map, aerial photograph or local planning document.

b. **Determine the total estimated value of the buildings inside your community or state.** Establish the total approximate replacement value of the buildings located inside the hazard area. This information is also estimated by occupancy class in HAZUS or can be gathered from the tax assessment values of individual buildings, or by developing an estimate for the area as a whole.

c. **Determine the number of people inside your community or state.** Estimate the current population inside your jurisdiction. Use HAZUS, current Census data, or local figures to estimate the current population. You should note whether or not you have large daytime, nighttime, or seasonal differences in your population.

2. Estimate the total number of buildings, total value of buildings, and number of people in each of your hazard zones.

You will now use HAZUS, GIS, or printed maps to overlay the hazard areas developed in Step 2 on top of your base map to determine the number and value of the buildings and the population that is vulnerable to the hazard events.

a. **Determine the total number of buildings inside the hazard area.** Establish the total number of buildings located inside the hazard area for each hazard type. You can use HAZUS to group the buildings by occupancy class or use GIS, a tax assessment map, or aerial photograph to determine the number of buildings in the hazard area.

b. **Determine the total estimated value of the buildings inside the hazard area.** Establish the total approximate replacement value of the buildings located inside the hazard area. You can use HAZUS, GIS, tax assessment values, or develop an estimate of the value of the buildings inside the hazard area as a whole.

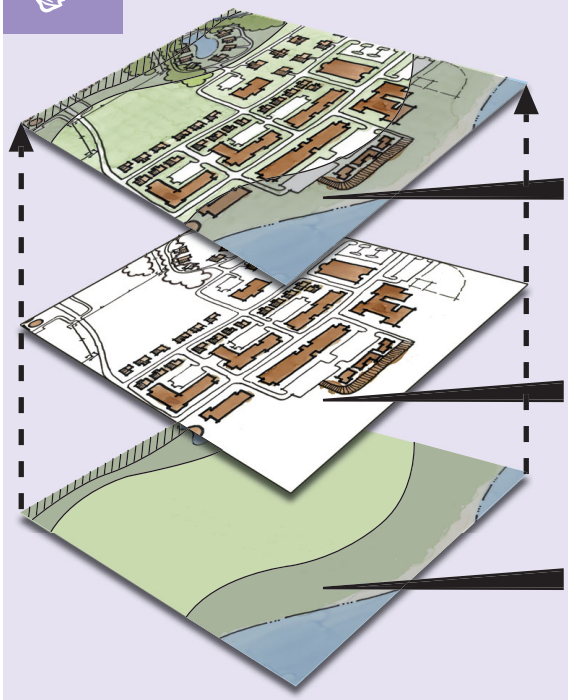
c. **Determine the number of people inside the hazard area.** Estimate the current population inside the hazard area. Use HAZUS, current Census data, local figures, or an estimate of the population. Once again, you should note if there is a large daytime, nighttime, or seasonal population change inside the hazard area.

Estimating future development will be addressed in the next phase of the Mitigation Planning Process. The phase "Develop a Mitigation Plan" will include how-to guidance on estimating future land use and population and will account for future risks. For now, you should note areas where future development or redevelopment may occur, to determine whether those areas are subject to hazards.

Your inventory should characterize a building and its contents, as well as its functions and the effect of the function on the buildings, its service to the community or state and its effect on the economy. You should ask yourself, what would happen to the community or state if the building's function were interrupted?

For example, providing drinking water is a normal function of local government, usually undertaken by the public works department. If your water treatment plant is located in a hazard area and can be damaged by a natural hazard event such as a flood or an earthquake, then it should be included in your inventory. In addition to the potential for physical damage to the plant itself, you should estimate the cost to businesses and residents for the period of time in which potable water might not be available.

An overlay can be produced by hand using a light table or through the use of GIS.



A map showing the location of the community's assets can be produced…

…by overlaying the base map for the community…

…with a map delineating hazard area boundaries.

Using a light table (or GIS if available), overlay this information to see which structures are located in more than one hazard zone and which areas of the community or state are more or less susceptible to different hazards.

This overlay mapping technique will also be helpful in looking at areas within the community that are not currently developed but could be in the future. There is no better time to avoid potential problems than before ground is broken for residential, commercial, or industrial land uses. By determining if any areas in the community that could be developed are prone to specific hazards, actions can be taken in advance that will serve to limit loss of life and property in the event of a disaster event.

3. Calculate the proportion of assets located in hazard areas.

To determine the proportion of structures, building value, or people in your hazard areas compared to your community or state, divide the number or value in your hazard area by the total number or value in your jurisdiction. For example, if you determined that you have 20 residential structures in your community and 10 of those are located in the 100-year floodplain, then 50 percent, or 10 divided by 20, of your residential structures are located in your flood hazard area.

States should inventory (or arrange for communities to perform these assessments as part of their inventories) state facilities (including critical facilities) and properties lying in hazard areas, including:

- Infrastructure such as highways, bridges, waterways, and utilities;
- Air, water, and other transportation terminals or ports;
- Lifelines and communication systems, such as phone lines and antennae, or water and sewage treatment plants; and
- Public recreation areas, parks, or forests.

As you complete your inventory, determine how you will incorporate the results into your statewide risk assessment.

You should begin to see the pattern of potential damage across the state as communities complete their individual inventories.

4. Determine the location of expected growth in your community.

By referring to your local comprehensive plan, or by talking with community officials, learn where future growth is expected to take place. Note whether these areas lie within hazard areas.

Task B. Determine whether (and where) you want to collect additional inventory data.

This is a critical juncture in your risk assessment. You may decide to end your inventory at this point, knowing the total estimated population, number of buildings, and value of buildings in the hazard areas, or you may decide to continue to gather additional inventory information described in Task C.

Ending your inventory now will only provide you a very broad picture of the potential extent of damage likely from a hazard event. When time, money, or other resources are scarce, a truncated inventory such as this can be helpful in demonstrating in a very broad sense what your community stands to lose during a hazard event. It can be particularly useful to convince decision-makers of the need for further study to determine potential losses from certain hazards. However, these figures will NOT allow you to specify the structures that are at greatest risk of damage, making objective determination of mitigation priorities difficult in the next phase of the planning process.

Collecting additional information will allow you to determine to what extent your assets can be damaged in a hazard event, giving you a more accurate estimate of the losses (cost of damages) to your community. At this time, loss estimation factors are available for floods, coastal storms, and earthquakes. In order to benefit from the use of these factors, you will need to gather additional inventory information.

The decision whether to gather additional information for some or all of your hazard areas is a subjective one. Your decision may be based on your need for detailed hazard- or site-specific information or the need to determine where to focus your information or the need to determine where to focus your mitigation efforts as part of the next phase of the Natural Hazard Mitigation Planning Process. As you decide how much information to collect, ask yourself these questions:

1. Is there enough data to determine which assets are subject to the greatest potential damages?
2. Is there enough data to determine whether significant elements of the community are vulnerable to potential hazards?
3. Is there enough data to determine whether certain areas of historic, environmental, political, or cultural significance are vulnerable to potential hazards?

Community Vulnerability Assessment Tool (CVAT) CD-ROM

The CVAT can be used to run a preliminary vulnerability assessment to help you determine whether or where you would like to spend more time or resources on collecting additional data. The CVAT provides guidance on conducting community-wide vulnerability assessments. It also provides a case study demonstrating the process for analyzing physical, social, economic, and environmental vulnerability to hazards at the local level. For more information, visit the NOAA Web site at http://www.csc.noaa.gov/products.

4. Is there concern about a particular hazard because of its severity, repetitiveness, or likelihood of occurrence?
5. Is additional data needed to justify the expenditure of community or state funds for mitigation initiatives?

You may want to gather detailed loss information on all of your potential hazards, one hazard, or a particular area or neighborhood affected by a hazard. You may also decide to gather detailed loss information for all your critical and essential facilities, or you may focus your attention on just the schools or hospitals. Additionally, if you plan to use the loss information to help you identify and/or prioritize mitigation projects in the next phase of the planning process, you may find it necessary to gather the additional information in order to perform a benefit-cost analysis.

If you wish to end your inventory collection at this point

Go to Summary (page 3-13)

Task C. Compile a detailed inventory of what can be damaged by a hazard event.

You will now begin to develop a more detailed inventory of the types of assets that are located in hazard areas, and the characteristics of those assets. Collecting data on these characteristics will help you determine the losses to these assets from different hazards.

1. Determine the priorities for your inventory collection efforts.

After you have determined for which hazard events you will gather additional information, you will determine your priorities for collecting the information. Choices about how much information you can reasonably gather may be particularly important for large communities or for areas with a dense concentration of assets. In some cases, the hazard profiles created in Step 2 will have already helped focus your efforts by eliminating areas without a significant hazard threat from your immediate concern.

HAZUS

HAZUS separates critical buildings and facilities into the five categories shown below based on their loss potential. For the purpose of this guide, all of the following elements are considered **critical facilities:**

- **Essential Facilities** are essential to the health and welfare of the whole population and are especially important following hazard events. The potential consequences of losing them are so great, that they should be carefully inventoried. Be sure to consider not only their structural integrity and content value, but also the effects on the interruption of their functions because the vulnerability is based on the service they provide rather than simply their physical aspects. Essential facilities include hospitals and other medical facilities, police and fire stations, emergency operations centers and evacuation shelters, and schools.
- **Transportation Systems** include airways – airports, heliports; highways – bridges, tunnels, roadbeds, overpasses, transfer centers; railways – trackage, tunnels, bridges, rail yards, depots; and waterways – canals, locks, seaports, ferries, harbors, drydocks, piers.
- **Lifeline Utility Systems** such as potable water, wastewater, oil, natural gas, electric power and communication systems.
- **High Potential Loss Facilities** are facilities that would have a high loss associated with them, such as nuclear power plants, dams, and military installations.
- **Hazardous Material Facilities** include facilities housing industrial/hazardous materials, such as corrosives, explosives, flammable materials, radioactive materials, and toxins.

Following are some ideas on how to focus your time and money on the most urgent and important elements within your community or state.

- Identify **critical facilities** that are important to your community or state. (See the definitions above).
- Identify **vulnerable populations** such as non-English speaking people or elderly people who may require special response assistance or special medical care after a disaster.
- Identify **economic elements** such as major employers and financial centers in your jurisdiction that could affect the local or regional economy if significantly disrupted.
- Identify areas with **special considerations** such as areas of high-density residential or commercial development that, if damaged, could result in high death tolls and injury rates.
- Identify **historic, cultural, and natural resource areas** including areas that may be identified and protected under state or federal law.
- Identify **other important facilities** which help ensure a full recovery of your community or state following a hazard event. These would include: government func-

tions, major employers, banks, and certain commercial establishments, such as grocery stores, hardware stores, and gas stations.

2. Gather building-specific information about the assets.

You will gather building-specific information regardless of the hazard that you are assessing. The list below discusses the type of information needed to calculate potential losses from different hazards in Step 4. You may want to gather this information for all of your hazards in combination with the hazard-specific information listed in the next step.

a. **Determine the size of the building.** Measured by the square foot, the size of the buildings is used to estimate both the replacement and function value of buildings. Sources of information include the tax assessment, building, zoning, or planning departments.

b. **Determine the replacement value.** This is usually expressed in terms of cost per square foot and reflects the present-day cost of labor and materials to construct a

The type of hazard event will influence what information should be gathered in the inventory. In Steps 1 and 2 it became apparent that because there are fundamental differences in the hazard types, there are corresponding differences in the type of information and data you are collecting.

For example, floodwaters tend to inundate whatever is within a given area to a known consistent depth. However, hazard events such as tornadoes that are equally likely to occur anywhere in the community are usually profiled in terms of the magnitude (e.g., wind speed). Therefore, for hazard events such as floods, the information gathered will be based on the geographic area expected to be flooded, based on past experience. For a less predictable hazard such as a tornado, you will be less concerned with specific location; instead, you will focus on the construction characteristics for buildings throughout the community.

The average replacement values were adjusted by the Consumer Price Index (CPI) to represent 2000 dollar figures.

The CPI is the ratio of the value of a basket of goods in the current year to the value of that same basket of goods in the previous year. It measures the average level of prices of the goods and services typically consumed by an urban American family. The http://woodrow.mpls.frb.fed us/research/data/us/calc/hist1800.cf Website can be used to adjust historic dollar figures to current year dollar figures.

Average Building Replacement Value per Square Foot

Occupancy Class	Total $/sq. ft.
Single Family Dwelling	77
Mobile Home	52
Multi-family Dwelling	98
Temporary Lodging	102
Institutional Dormitory	98
Nursing Home	89
Retail Trade	67
Wholesale Trade	53
Personal/Repair Services	92
Professional/Tech. Services	87
Banks	151
Hospital	145
Medical Office/Clinic	112
Entertainment & Recreation	131
Theaters	98
Parking	30
Heavy Industrial	69
Light Industrial	69
Food/Drugs/Chemicals	69
Metals/Minerals Processing	69
High Technology	69
Construction	69
Agriculture	26
Church/Non-Profit Offices	113
General Services	88
Emergency Response	130
Schools	91
Colleges/Universities	115

Source: HAZUS

building of a particular size, type, and quality. The replacement value is the current cost of returning a physical asset to its pre-damaged condition.

If you do not already have the replacement values from HAZUS or a local source use the table to the left and find the average replacement values per square foot. These costs are based on national averages for materials and installation and may need to be adjusted to account for regional differences. For example, building materials and supplies cost more in Hawaii than Kansas. Finally, multiply the cost per square foot by the size (in square feet) of the building you are assessing.

c. **Determine the content value.** If you do not already have the estimated content values from HAZUS or a local source, use the table at right to estimate the content value. Find the type of building you are assessing and determine the percent of the content replacement value. Multiply this percent by the building replacement value to calculate the content replacement value. Although there is not a standard cost variation table, you should keep in mind that some contents such as antiques or collectibles may be worth more than the average values. Increase your estimated content loss for these types of contents as you deem necessary.

Contents Value as Percentage of Building Replacement Value

Occupancy Class	Contents Value (%)
Residential (including temporary lodging, dormitory, and nursing homes)	50
Commercial (including retail, wholesale, professional, services, financial, entertainment & recreation)	100
Commercial (including hospital and medical office/clinic)	150
Commercial Parking	50
Industrial (including heavy, light, technology)	150
Industrial Construction	100
Agriculture	100
Religion/Non-Profit	100
Government Emergency Response	150
Government General Services	100
Education Schools/Libraries	100
Education Colleges/Universities	150

Source: HAZUS

d. **Determine the function use or value.** This represents the value of a building's use or function that would be lost if it were damaged or closed. A standard way to calculate the monetary damage from losing public functions is to use the budget of the service as a proxy for its value to the community. For private functions, the table on page 3-12 shows the average annual sales or production based on square footage. Using the table, find the type of function you are assessing and multiply the index by the structure size. The damages from "loss of function" are often much greater than physical damage to a structure.

Example 1

To find the annual sales from a 15,000 square foot grocery store, you would multiply the structure size by $30 per square foot (from the table at right).

15,000 x $30

The annual sales would be $450,000.

Example 2

If a public library will be lost for three months due to damage from a 100-year flood, you could determine the damages from the loss of function by multiplying the monthly budget of the library (overhead, rent, staff salaries, etc.) by three months.

Annual Gross Sales or Production (Dollars per Square Foot)

Occupancy Class	Annual Sales ($ / ft²)
Commercial	
Retail Trade	30
Wholesale Trade	43
Industrial	
Heavy	400
Light	127
Food/Drugs/Chemicals	391
Metals/Minerals Processing	368
High Technology	245
Construction	431
Agriculture	
Agriculture	83

Source: HAZUS

e. **Determine the displacement cost.** The displacement cost is the dollar amount it would cost for the function (business or service) to be relocated to another structure because of a hazard event. These costs include rent for temporary building space per month, one-time displacement costs to set up operations in the new space, lost rent per month from all tenants, and other costs of displacement.

f. **Determine the occupancy or capacity.** Determine how many people the asset, such as a building or bridge, is designed to hold or service. Building capacities are available from local fire departments and/or fire marshal's offices. Bridge load ratings can be obtained from the responsible local, state, or federal transportation departments.

3. Gather hazard-specific information about the assets.

The pages that follow discuss the type of information needed to calculate potential losses from different hazards in Step 4. Because the characteristics of different hazards create the need for different types of data, you should review your unique combination of hazards to determine how you may want to approach data collection. The following table illustrates how different hazards may require different data.

Building Data Requirements By Hazard

Building Characteristics	Flood	Earthquake	Tsunami	Tornado	Coastal Storm	Landslide	Wildfire
Building Type / Type of Foundation	✓	✓	✓		✓		
Building Code Design Level / Date of Construction	✓	✓	✓	✓	✓		✓
Roof Material				✓	✓		✓
Roof Construction				✓	✓		✓
Vegetation							✓
Topography	✓				✓	✓	✓
Distance from the Hazard Zone	✓		✓		✓	✓	✓

Summary

After you have completed Step 3, you will know the quantity of buildings, people, and building values that lie in the different hazard areas and what proportion of the community this represents. If you decided to develop a more detailed inventory of what lies in these hazard areas, you will also know about many of the characteristics of the buildings and population. This will enable you to estimate losses resulting from hazard events and to determine where to best begin to address mitigation issues and focus your resources. Above all, you now have a better understanding of what is at risk in your community and an emerging picture of what your community stands to lose after a hazard event.

Step 3 most likely will present the greatest challenge in the loss estimation process and has the greatest potential to be a resource drain, but it is actually the most meaningful step. The degree to which you invest time and resources in the inventory will determine the quality of the loss estimation in Step 4, and ultimately your ability to prioritize mitigation actions during the next phase of the planning process.

If you have completed your inventory

Go to Step 4

to estimate the losses.

The Hazardville Post

Vol. CXI No. 256 Thursday, September 13, 2001

Hazardville Risk Assessment Back On Track

(Part 3 of a 4 part series on the Risk Assessment Process)

[Hazardville, EM] Town Council members held a special meeting Monday, upset that the inventory had not yet been completed. Joe Norris, the lead planner of the Town of Hazardville Organization for Risk Reduction (THORR), testified that the task force has been working since April to collect data on the hazards that could potentially affect Hazardville and assess the effects of those hazards on the town. Norris explained that collecting the initial information on the town and the hazards went fairly quickly.

Norris said, "The initial inventory was simplified due to the assistance offered by the State of Emergency Hazard Mitigation Officer." To get the ball rolling, the State of Emergency Office of Emergency Preparedness (EOEP), used a loss estimation tool developed by the Federal Emergency Management Agency, Hazards U.S. (HAZUS) to provide an initial inventory of critical facilities and buildings in the community. This information was added to the base map and assessed against each of the hazard zones. The final tally from the HAZUS inventory is shown in Table 1.

The slowdown came when the THORR reviewed the initial numbers and realized just how much and what was located in the hazard zones. Norris exclaimed, "Do you realize that all five commercial establishments and the only industrial plant in the Town of Hazardville can be impacted from four different hazards, and four out of the five business can be impacted by a fifth hazard?" The school, which substitutes as an emer-

(see **Risk**, page 3-15)

Table 1: HAZUS Inventory Totals

Occupancy Class	TOTAL ASSETS	Flood	Earthquake*	Tsunami	Coastal Storm	Tornado*	Wildfire	Landslide
Residential	62	16 (25%)	62	3 (4.8%)	18 (29%)	62	19 (30.6%)	2 (3.2%)
Commercial	5	4 (80%)	5	5 (100%)	5 (100%)	5	0	0
Industrial	1	0	1	1 (100%)	1 (100%)	1	0	0
Agricultural	2	1 (50%)	2	0	1 (100%)	2	2 (100%)	2 (100%)
Religion/ Non-Profit	4	1 (25%)	4	2 (50%)	4 (100%)	4	0	2 (50%)
Government	7	4 (57%)	7	1 (14%)	7 (100%)	7	5 (71%)	1 (14%)
Education	1	1 (100%)	1	1 (100%)	1 (100%)	1	0	
Number of Buildings	82	31 (37.8%)	82	14 (17%)	41 (50%)	82	29 (35%)	6 (7.3%)
Approximate Value ($M)	34.357	12.334 (35.8%)	34.357	12.396 (36%)	21.520 (62.6%)	34.357	6.641 (19%)	3.900 (11%)
Number of People	413	74 (18%)	413	9 (2.2%)	165 (40%)	413	29 (7%)	19 (4.6%)

* These hazards are random in nature and could affect any portion or the whole town.
Source: State of Emergency Office of Emergency Preparedness – HAZUS.

Hazardville Risk Assessment

Risk

(continued from page 3-14)

gency shelter, is vulnerable to five of seven hazards. In addition, over $21 million dollars in assets are vulnerable to coastal storms alone, including the police/fire department.

Based on the HAZUS data, THORR unanimously voted in favor of gathering additional inventory data on all of the town's critical facilities, as well as the historic lighthouse and buildings that have been flooded more than twice. Norris explained, "The THORR realized that more data was needed in order to determine where the highest loss could occur or what should be our top priority for mitigation; however, inventorying each of the buildings had been more time consuming than anticipated and identifying the number of buildings in the various hazard areas quickly overwhelmed the volunteers."

So, in addition to working with the EOEP, THORR worked with numerous volunteer and community groups to complete the inventory. The local Girl Scout troop verified the location of all the buildings in the 100-year floodplain, and the volunteer fire department conducted a sidewalk survey to inventory the wildfire hazard area, including the Clearview Acres Subdivision. Members of the University Geology Club inventoried the landslide hazard areas, and the department of Public Works received training in Rapid Visual Screening for seismic and wind vulnerability and inventoried all public buildings for earthquakes and tornadoes.

According to Norris, the final results of the loss estimation should be available in about two months after they complete the final step of estimating losses.

Task C. Compile a more detailed inventory of what can be damaged by a flood hazard event.

1. Determine priorities for your inventory collection efforts.

In large communities, you may choose to prioritize your inventory by selecting the more hazardous floodplains (based on Step 2) first, by starting with the older buildings, critical facilities, or the assets that are closest to the flood hazard such as those in the floodway. For example, buildings that were constructed before local or state floodplain ordinances went into effect will most likely not be elevated to or above the expected flood level, and are most susceptible to flood damage. Buildings whose structures or contents are most susceptible to flood damage, such as wood frame buildings, manufactured homes, or buildings with delicate contents or expensive machinery are also more vulnerable to flood damage. You should also identify repetitive loss properties as part of this activity.

2. Gather building-specific information about the assets.

Gather the building-specific information including size, replacement value, content value, function use or value, displacement cost, occupancy or capacity. For more information refer to Task C, number 2 on page 3-10.

Under NFIP guidelines, repetitive loss structures include any currently insured building with two or more flood losses (occurring more than ten days apart) greater than $1,000 in any 10-year period since 1978.

States should provide communities with information on historic floods throughout the state so communities will know what type of damage has occurred (even if it didn't occur within that particular community).

States should ensure that lists of repetitive loss properties are kept up to date and that communities have the most current list. States should contact their FEMA Regional Office for this information.

FEMA also maintains a national list of properties that comprise the "Repetitive Loss Target Group". These are repetitive loss properties that have either experienced four or more losses with the characteristics above, or have had losses that cumulatively exceed the property value of the building.

3. Gather hazard-specific information about the assets.

In addition to the items shown in the table below, the following information will be used later in Step 4 to determine flood vulnerability:

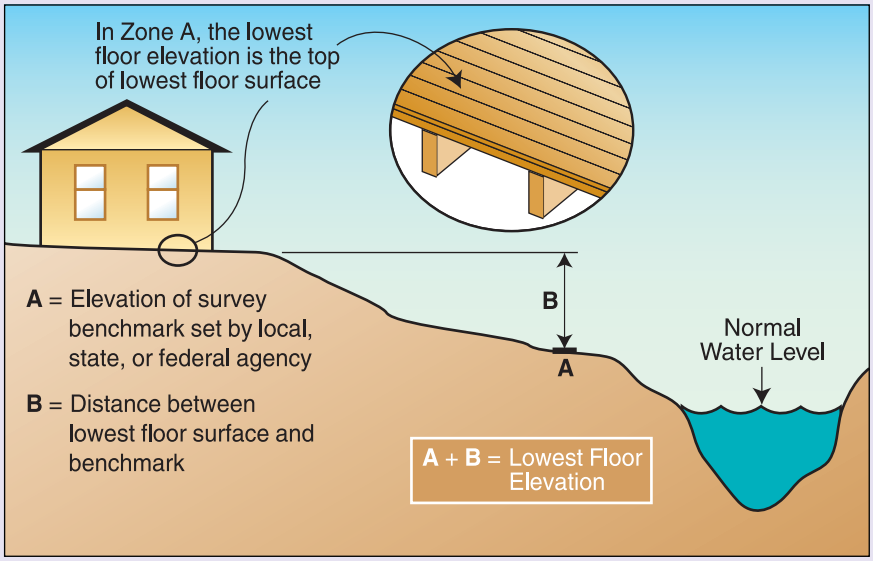
- **Lowest floor elevation.** Identify the elevation of the lowest floor of the lowest enclosed area (including basement). This information can be obtained from an elevation certificate (found in the office of the local NFIP administrator, who also often serves as the local building official or planner) if the building was constructed after your floodplain management ordinance was in force. It may also be available from a recorded subdivision plat, site survey, or building permit.

A basic approach to estimating the lowest floor elevation is to estimate the elevation for a whole block of similarly located buildings.

You may also consider generalizing your inventory by making an assumption that buildings constructed after the FIRM was published are above the base flood elevation and buildings constructed prior to the FIRM are below the base flood elevation.

If a lowest floor elevation has not been recorded, it can be determined in a number of ways. The most accurate way is to hire a professional land surveyor to field-measure the lowest floor elevation from a local surveying benchmark or other point of known elevation. Other less accurate methods include measuring (such as with a hand level) from a nearby benchmark, a neighbor's property that has been surveyed, or any other point of known elevation. Also, property owners who have experienced prior flooding may have marked the water level on the building. These property owners can check local records for the elevation of the flood during that storm and estimate the lowest-floor elevation relative to their high-water mark.

Lowest Floor Elevation (A Zones)



- **Base Flood Elevation.** The base flood elevation is the elevation (referenced to a datum) of the flood having a one percent chance of being equaled or exceeded in any given year. This information can be found on the FIRM and flood profile. The following diagram shows how to find the BFE at a given point in the floodplain.

To determine the BFE using the FIRM:

① Locate a feature(s) on the FIRM, near the site you are assessing, that also appears on the FIS Flood Profile, such as a bridge, highway, or cross-section.

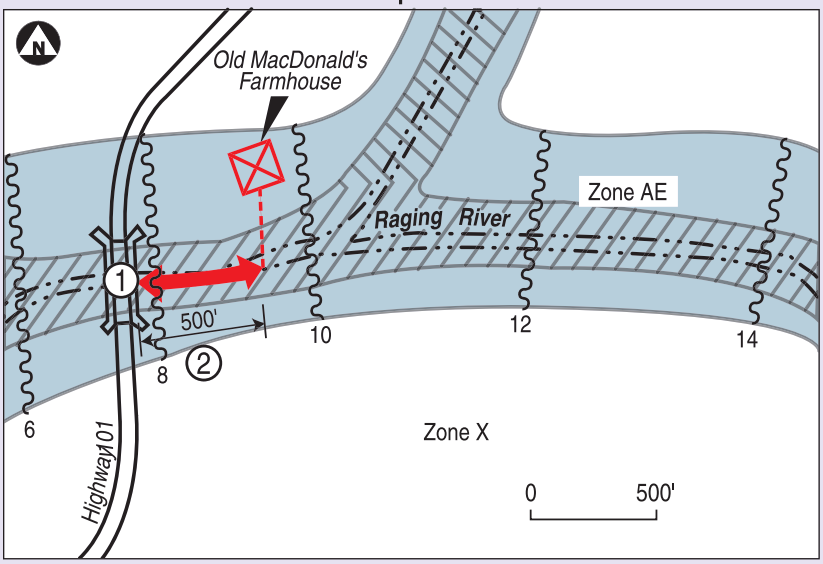
② Calculate the distance from the feature along the stream to the site you are assessing using the scale used on the FIRM.

③ Locate the site you are assessing on the FIS Flood Profile by using the scale on the FIS to measure the distance from the feature to the site.

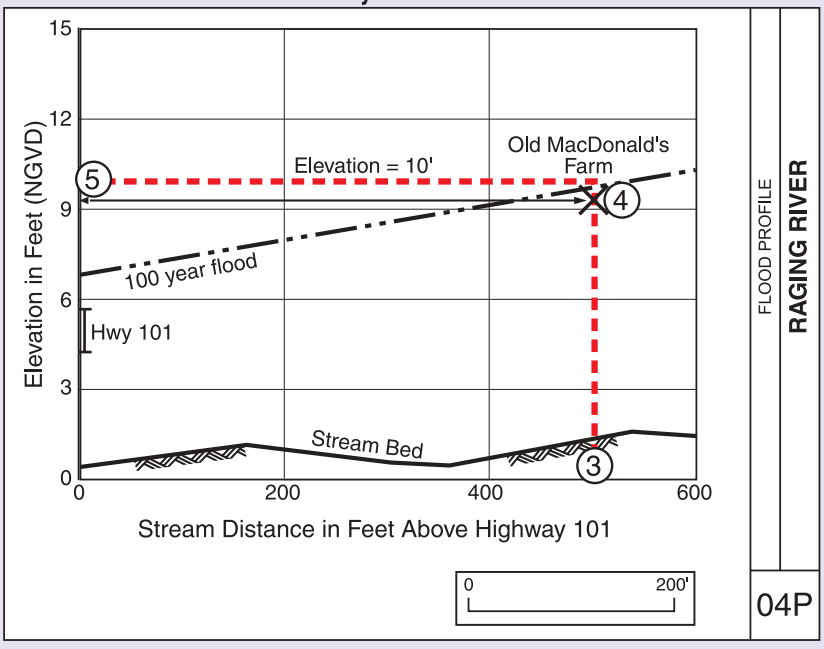
④ Follow a vertical line up to the water surface line on the Flood Profile.

⑤ Follow a horizontal line to the y-axis to read the elevation.

Hazardville Flood Insurance Rate Map



Hazardville Flood Insurance Study



Building Data Requirements By Hazard

Building Characteristics	Flood	Earthquake	Tsunami	Tornado	Coastal Storm	Landslide	Wildfire
Building Type / Type of Foundation	✓	✓	✓		✓		
Building Code Design Level / Date of Construction	✓	✓	✓	✓	✓		✓
Roof Material				✓	✓		✓
Roof Construction				✓	✓		✓
Vegetation							✓
Topography	✓				✓	✓	✓
Distance from the Hazard Zone	✓		✓		✓	✓	✓

Go to the next hazard on your list to inventory

or if you are finished with all your hazard inventories

Go to Step 4

Task C. Compile a more detailed inventory of what can be damaged by an earthquake hazard event.

1. Determine priorities for your inventory collection efforts.

Determining inventory priorities for earthquakes requires consideration of the potential intensity of the earth movements. For example, some buildings, such as those constructed of unreinforced masonry, perform very poorly in earthquakes. In addition, buildings constructed prior to seismic building code requirements or under low seismic building codes will also perform poorly in earthquakes of a given intensity. With this in mind, you might choose to inventory only those at first, to see what risks are evident before proceeding with a full inventory. This can be accomplished through a seismic evaluation of your buildings.

This method of selecting elements with the most apparent vulnerability determines whether there is sufficient vulnerability to justify additional evaluations. For example, if you initially include in your inventory only those buildings that would do poorly in an earthquake of a known intensity and/or those with high occupancy and conclude that there is still not much risk, you may wish to assume that other types of buildings or structures will be at even lower risk.

Code Seismic Design Level

States and communities change their building codes over time as more is learned about hazards and construction techniques. The determination of high, moderate, or low code levels can be considered subjective. You should talk with your local and/or state code officials to determine this aspect of vulnerability.

For example, in areas of high seismicity (e.g., coastal California), buildings of newer construction (e.g., post-1973) are best represented by High-Code damage functions, while buildings of older construction would be best represented by Moderate-Code damage functions, if built after about 1940, or by Pre-Code damage functions, if built before about 1940 (i.e., before seismic codes existed). Pre-Code damage functions are appropriate for modeling older buildings that were not designed for earthquake load, regardless of where they are located in the United States.

NEHRP Handbook for the Seismic Evaluation of Existing Buildings (FEMA 178) presents a nationally applicable method for engineers to identify buildings or building components that present unacceptable risks in an earthquake. Four structural subsystems in which deficits may exist are identified:

- Vertical elements resisting horizontal loads;
- Horizontal elements resisting lateral loads;
- Foundations; and
- Connections between structural elements or subsystems.

Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook (FEMA 154) and Supporting Documentation (FEMA 155) present a method for quickly identifying buildings posing risk of death, injury, or severe curtailment in use following an earthquake. Trained personnel can use the methodology known as "Rapid Screening Procedure (RSP)" to identify potentially hazardous buildings. This identification is based on a 15- to 30-minute exterior inspection, using a data collection form included in the handbook. Twelve basic structural categories are inspected, leading to a numerical "structural score" based on visual inspection. Building inspectors are the most likely group to implement an RSP, although this report is also intended for building officials, engineers, architects, building owners, emergency managers, and interested citizens. The supporting documentation reviews the literature and existing procedures for rapid visual screening.

2. Gather building-specific information about the assets.

Gather the building-specific information including size, replacement value, content value, function use or value, displacement cost, occupancy or capacity. For more information refer to Task C, number 2 on page 3-10.

If you are using HAZUS to estimate your earthquake losses, these calculations will be completed within the program.

3. Gather information about the assets.

In addition to the information shown in the table below, the following information will be needed to determine earthquake vulnerability as part of Step 4:

- **Seismic design building code.** One aspect of structure vulnerability is based on building codes. Older buildings constructed under a low seismic design building code or without any seismic considerations are more vulnerable to earthquakes of a given intensity than buildings constructed to a high or moderate seismic design building code. Determine the level (high, moderate, low, or pre-code) of seismic design building code that is currently in effect, when it went into effect, and what levels of seismic codes have been in effect in the past. Based on this information work with your building code department to determine under which code the buildings in your inventory were designed. Keep in mind that buildings built under a code with low seismic design provisions could have been subsequently retrofitted under a more stringent code.

Using HAZUS to identify buildings constructed before the adoption of seismic building codes can help you quickly identify buildings that will be vulnerable to earthquakes.

Intensity is a subjective measure of the strength of the shaking experienced in an earthquake. Intensity is based on the observed effects of ground shaking on people, buildings, and natural features. It varies from place to place within the disturbed region depending on the location of the observer with respect to the earthquake epicenter. The "intensity" reported at different points generally decreases away from the earthquake epicenter. Local geologic conditions strongly influence the intensity of an earthquake; commonly, sites on soft ground or alluvium have intensities 2 to 3 units higher than sites on bedrock. The **Modified Mercalli Scale** represents the local effect or damage caused by an earthquake.

It is possible to relate the PGA value you identified in Step 2 to the Mercalli scale. (See table.)

Modified Mercalli Intensity and PGA Equivalents

MMI	Acceleration (%g) (PGA)	Perceived Shaking	Potential Damage
I	< 0.17	Not Felt	None
II	0.17 - 1.4	Weak	None
III	0.17 - 1.4	Weak	None
IV	1.4 - 3.9	Light	None
V	3.9 - 9.2	Moderate	Very Light
VI	9.2 - 18	Strong	Light
VII	18 - 34	Very Strong	Moderate
VIII	34 - 65	Severe	Moderate to Heavy
IX	65 - 124	Violent	Heavy
X	> 124	Extreme	Very Heavy
XI	> 124	Extreme	Very Heavy
XII	> 124	Extreme	Very Heavy

Source: USGS

Building Data Requirements By Hazard

Building Characteristics	Flood	Earthquake	Tsunami	Tornado	Coastal Storm	Landslide	Wildfire
Building Type / Type of Foundation	✓	✓	✓		✓		
Building Code Design Level / Date of Construction	✓	✓	✓	✓	✓		✓
Roof Material				✓	✓		✓
Roof Construction				✓	✓		✓
Vegetation							✓
Topography	✓				✓	✓	✓
Distance from the Hazard Zone	✓		✓		✓	✓	✓

Go to the next hazard on your list to inventory

or, if you are finished with all your hazard inventories

Go to Step 4

Tsunamis

Task C. Compile a more detailed inventory of what can be damaged by a tsunami hazard event.

1. Determine priorities for your inventory collection efforts.

If your community has a relatively small tsunami area, you may decide to inventory all of the assets inside the hazard boundary on your base map. If you have a large tsunami area or if numerous buildings are located inside the hazard boundary, you may decide to prioritize your inventory by starting with those closest to the shoreline, and critical facilities.

2. Gather building-specific information about the assets.

Gather the building-specific information including size, replacement value, content value, function use or value, displacement cost, occupancy or capacity. For more information refer to Task C, number 2 on page 3-10.

3. Gather information about the assets.

After you have made a list of all the assets located inside the tsunami hazard area, you will need to gather information shown in the table below.

Building Data Requirements By Hazard

Building Characteristics	Flood	Earthquake	Tsunami	Tornado	Coastal Storm	Landslide	Wildfire
Building Type / Type of Foundation	✓	✓	✓		✓		
Building Code Design Level / Date of Construction	✓	✓	✓	✓	✓		✓
Roof Material				✓	✓		✓
Roof Construction				✓	✓		✓
Vegetation							✓
Topography	✓				✓	✓	✓
Distance from the Hazard Zone	✓		✓		✓	✓	✓

Go to the next hazard on your list to inventory

or, if you are finished with all your hazard inventories

Go to Step 4

Tornadoes

Meteorologists use the Fujita scale to determine the intensity of tornadoes.

Most tornadoes are in the F0-F2 class. Building to modern wind standards provides significant property protection from these hazard events; however, a community in the direct path of a violent tornado may experience extensive damages. Designing buildings to extreme wind speeds, such as those associated with an F-3 or greater tornado is beyond the scope of current building codes.

The Building Performance Assessment Report for the Oklahoma and Kansas Tornadoes (FEMA 342) includes a good description of tornadoes and associated damage.

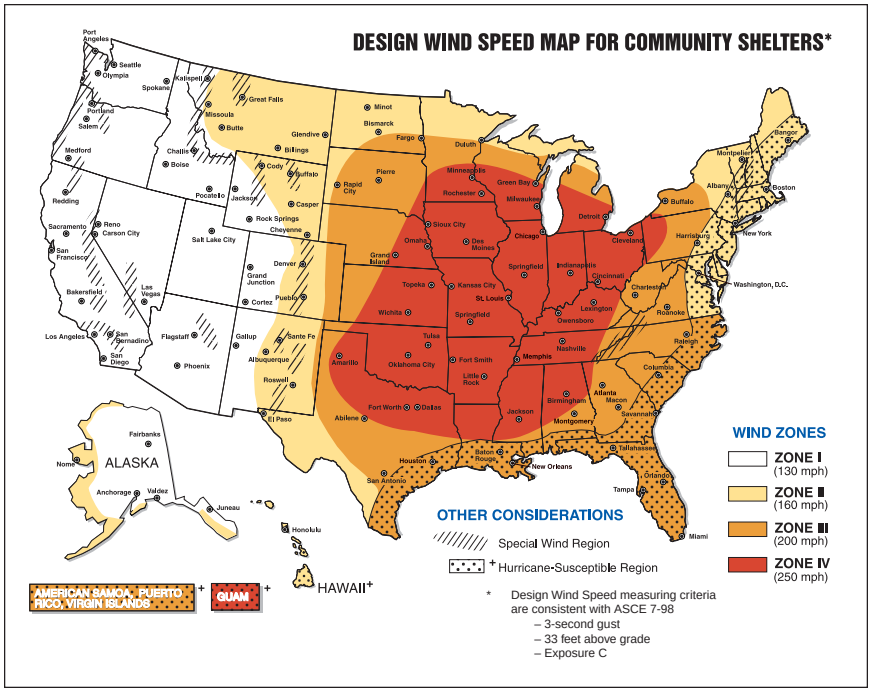
Communities should build new shelters or reinforce existing shelters to withstand the design wind speeds described in Step 2.

Task C. Compile a more detailed inventory of what can be damaged by a tornado hazard event.

1. Determine priorities for your inventory collection efforts.

Since tornadoes can possibly affect the whole community or state, it is very important to set some priorities because inventorying everything could be very labor and time intensive. If necessary, communities and states should narrow their inventory to assets that are of particular importance from a public safety, historical, economic, or environmental standpoint.

Communities that want to begin by identifying the assets that are not built to withstand the design wind speed, or assets that typically get damaged in tornadoes should examine the date of construction. For example, buildings that were constructed before local or state building codes went into effect, and/or buildings built to codes whose wind speed standards are below those indicated on the Design Wind Speed map shown below are more vulnerable to tornadoes.



2. Gather building-specific information about the assets.

Gather the building-specific information including size, replacement value, content value, function use or value, displacement cost, occupancy or capacity. For more information refer to Task C, number 2 on page 3-10.

3. Gather information about the assets.

After you have made a list of all the assets you wish to include inside the tornado hazard area, you will need to gather the information shown in the table below.

Building Data Requirements By Hazard

Building Characteristics	Flood	Earthquake	Tsunami	Tornado	Coastal Storm	Landslide	Wildfire
Building Type / Type of Foundation	✓	✓	✓		✓		
Building Code Design Level / Date of Construction	✓	✓	✓	✓	✓		✓
Roof Material				✓	✓		✓
Roof Construction				✓	✓		✓
Vegetation							✓
Topography	✓				✓	✓	✓
Distance from the Hazard Zone	✓		✓		✓	✓	✓

Go to the next hazard on your list to inventory

or if you are finished with all your hazard inventories

Go to Step 4

Task C. Compile a more detailed inventory of what can be damaged by a coastal storm hazard event.

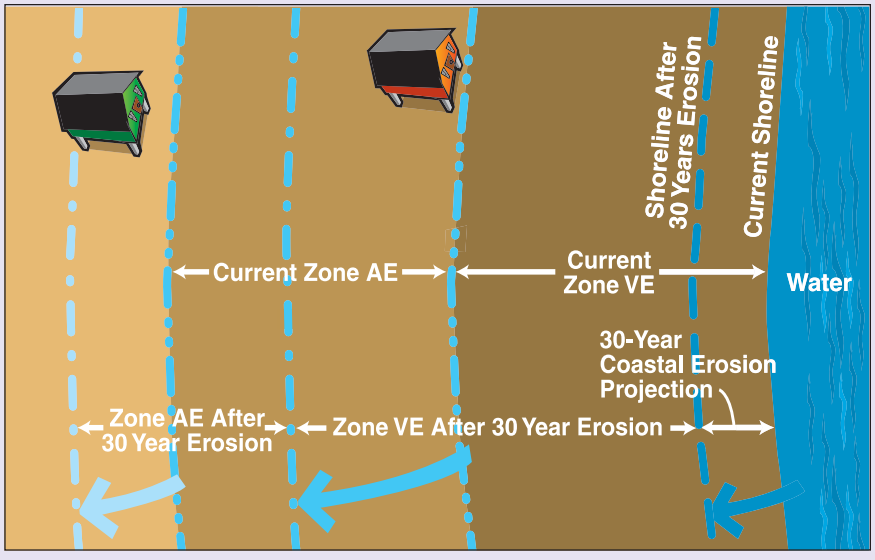
1. Determine priorities for your inventory collection efforts.

In addition to identifying critical facilities, you may further prioritize your inventory items by starting with buildings and other assets closest to the coastal storm hazard area or at the lowest elevations and prone to the highest potential flood and tidal surge levels, wave velocities, and erosion hazards.

Because hurricane-strength winds would likely affect whole communities or large portions of your state, conducting an inventory of every building subject to coastal storm winds would be very time and labor intensive. Therefore, if necessary, you should identify solely buildings or areas that may be more prone to wind hazards. The condition, age, and primary building materials can be indications of the building's physical vulnerability to wind and water hazards. Knowing the wind provisions of the building code and the floodplain management regulations in effect at the time of construction are essential in determining buildings' vulnerability to coastal storms.

Identify the assets that may be exposed to coastal storm hazards according to your priority system. For example, buildings or structures built before local floodplain ordinances went into effect most likely will not be elevated to or above the expected flood level or

Coastal flooding, high winds, and often erosion will affect the coastal storm hazard area in your community. Keep in mind that the flood zones and boundaries shown on the FIRM are based on conditions at the time the study was completed. As shoreline erosion occurs, the location of these zones and boundaries will change. For example, the red house, currently in Zone AE may be located in Zone VE within 30 years and the green house, currently out of the floodplain entirely, may be located in Zone AE within 30 years.



may have obstructions or an enclosed space below the elevated structure making them most susceptible to flood, wind, or storm surge damage. Also, buildings or structures built on high bluffs above the oceans or high cliffs such as those along the Great Lakes are susceptible to erosion of the land beneath the foundation. Once the erosion reaches the foundation, the house will be lost or damaged sufficiently to become uninhabitable.

2. Gather building-specific information about the assets.

Gather the building-specific information including size, replacement value, content value, function use or value, displacement cost, occupancy or capacity. For more information refer to Task C, number 2 on page 3-10.

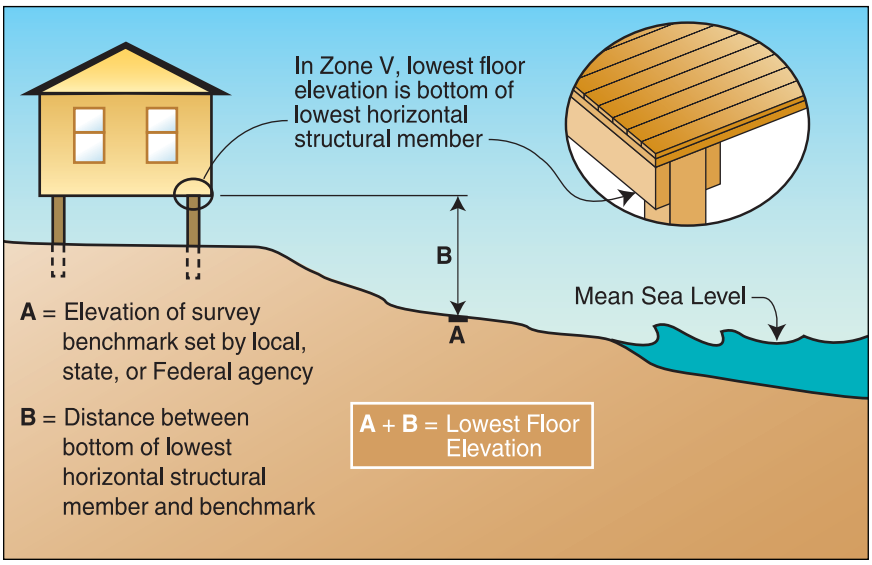
3. Gather Information about the assets.

In addition to the items listed in the table on the next page, the following information will be used in Step 4 to determine vulnerability to coastal storms:

- **Lowest floor elevation.** For V zones, the relevant elevation is that of the bottom of the lowest horizontal structural member, NOT the top of the lowest finished floor as used in non-coastal flood assessments. This definition is used for consistency with NFIP minimum floodplain management requirements.

A basic approach to estimating the lowest floor elevation is to estimate the elevation for a whole block of similarly located buildings.

Lowest Floor Elevation (V Zones)



This information can be obtained from an elevation certificate if the building was built after your community's floodplain management ordinance was in force. It also may be available from a recorded subdivision plat, site survey, or building permit.

- **Base Flood Elevation.** The base flood elevation is the elevation (referenced to a datum) of the flood having a one percent chance of being equaled or exceeded in any given year. This information can be found on the FIRM.

Building Data Requirements By Hazard

Building Characteristics	Flood	Earthquake	Tsunami	Tornado	Coastal Storm	Landslide	Wildfire
Building Type / Type of Foundation	✓	✓	✓		✓		
Building Code Design Level / Date of Construction	✓	✓	✓	✓	✓		✓
Roof Material				✓	✓		✓
Roof Construction				✓	✓		✓
Vegetation							✓
Topography	✓				✓	✓	✓
Distance from the Hazard Zone	✓		✓		✓	✓	✓

Go to the next hazard on your list to inventory

or, if you are finished with all your hazard inventories

Go to Step 4

Landslides

Task C. Compile a more detailed inventory of what can be damaged by a landslide hazard event.

1. Determine priorities for your inventory collection efforts.

Landslides usually affect infrastructure such as roads and bridges, but they can also affect individual buildings and businesses. If your community has a relatively small landslide area, you may decide to inventory all of the assets inside the hazard boundary on your base map. If you have a large landslide area or if numerous buildings are located inside the hazard boundary, you may decide to prioritize your inventory by starting with the critical facilities.

2. Gather building-specific information about the assets.

Gather the building-specific information including size, replacement value, content value, function use or value, displacement cost, occupancy or capacity. For more information refer to Task C, number 2 on page 3-10.

3. Gather information about the assets.

After you have made a list of all the assets located inside the landslide hazard area, gather the data listed in the table below.

Building Data Requirements By Hazard

Building Characteristics	Flood	Earthquake	Tsunami	Tornado	Coastal Storm	Landslide	Wildfire
Building Type / Type of Foundation	✓	✓	✓		✓		
Building Code Design Level / Date of Construction	✓	✓	✓	✓	✓		✓
Roof Material				✓	✓		✓
Roof Construction				✓	✓		✓
Vegetation							✓
Topography	✓				✓	✓	✓
Distance from the Hazard Zone	✓		✓		✓	✓	✓

Go to the next hazard on your list to inventory

or if you are finished with all your hazard inventories

Go to Step 4

Task C. Compile a more detailed inventory of what can be damaged by a wildfire hazard event.

1. Determine priorities for your inventory collection efforts.

If your wildfire hazard area is relatively small, you may decide to inventory all of the assets within your wildfire hazard boundary on your base map. If you have a large wildfire hazard area or if you have many assets within your hazard area, you may decide to prioritize your inventory by starting with the critical facilities. You can also prioritize by first inventorying the extreme wildfire hazard area and then as time and money permit, inventorying the high and moderate hazard areas.

Information about buildings that were constructed before local or state fire codes were adopted or upgraded can be gathered from the building permit or planning office.

2. Gather building-specific information about the assets.

Gather the building-specific information including size, replacement value, content value, function use or value, displacement cost, occupancy or capacity. For more information refer to Task C, number 2 on page 3-10.

3. Gather Information about the assets.

After you have made a list of all the assets located inside the wildfire hazard area, gather the data listed in the table below.

Building Data Requirements By Hazard

Building Characteristics	Flood	Earthquake	Tsunami	Tornado	Coastal Storm	Landslide	Wildfire
Building Type / Type of Foundation	✓	✓	✓		✓		
Building Code Design Level / Date of Construction	✓	✓	✓	✓	✓		✓
Roof Material				✓	✓		✓
Roof Construction				✓	✓		✓
Vegetation							✓
Topography	✓				✓	✓	✓
Distance from the Hazard Zone	✓		✓		✓	✓	✓

Go to the next hazard on your list to inventory

or if you are finished with all your hazard inventories

Go to Step 4